

Ar and fluorine atoms in elements constituting said gas molecule is four or less.

REMARKS

This is a full and timely response to the non-final Official Action mailed March 1, 2001. Reexamination and reconsideration in light of the above amendments and the following remarks are courteously requested.

By the foregoing amendment, claims 1 to 4, and 6 to 8 have been amended. No claims are added or canceled. Thus, claims 1 to 8 are currently pending for the Examiner's consideration.

The Examiner rejected claims 2 to 3, and 6 to 8 under 35 U.S.C. § 112, second paragraph. These claims have been carefully reviewed in light of the Examiner's comments. Following this amendment, all the remaining claims are believed to be in compliance with 35 U.S.C. § 112 and notice to that effect is respectfully requested.

The Examiner rejected claim 1 under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent No. 6,146,542 issued to Ha et al. ("Ha"). In light of the above amendment, the rejections are respectfully traversed.

Claim 1 is amended to recite that the fluorine gas is a fluorine-containing compound in gas form, where the compound includes a carbon atom. The Examiner concedes that Ha fails to disclose this limitation in paragraph 4 of the Action. Consequently, the rejection of claim 1 under 35 U.S.C. § 102(e) should be withdrawn. "A claim is anticipated [under 35 U.S.C. § 102] only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." Verdegaal Bros. v. Union Oil Co. of California, 2 U.S.P.Q.2d 1051, 1053 (Fed. Cir. 1987) (emphasis added). See M.P.E.P. § 2131.

The Examiner rejected claims 2 to 8 under 35 U.S.C. § 103(a) as being unpatentable over Ha. The following explains

why Ha fails to suggest to a person of skill in the relevant art that the dry etching of tungsten using a mixed gas including a fluorine-containing gas that includes a compound having fluorine and carbon in a molecule. It is pointed out that this limitation is also included in independent claim 4.

The present application mentions in the background section the disadvantages of using non-carbon compounds that include fluorine as an etching agent for tungsten. The disadvantages include microloading and an impractical etching rate.

In contrast, the Ha patent teaches in its background section that etching of tungsten is performed using fluorine compounds that do not contain carbon, including a mixture of SF₆ and NF₃. The passage of Ha cited by the Examiner simply reads that a fluorine compound is used to etch tungsten layers, but it would be inferred by a person of skill in the art that the same compounds cited in the background section for this process would be used according to the Ha invention.

This point is further established by the fact that Ha goes on to disclose that a carbon-containing fluorine compound could be used in a subsequent etching step to remove not the tungsten layers, but the diffusion barrier layer (column 4, lines 5 to 8). Therefore a person of ordinary skill in the art would read Ha and ascertain that Ha suggests that no change in etching gas from those disclosed in the background section would be used for etching tungsten layers, but that a carbon-fluorine type etching gas could be used in subsequent etching steps.

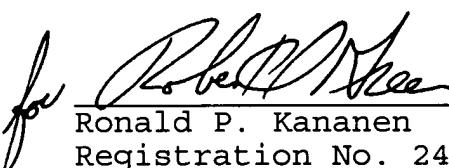
Because Ha fails to teach or suggest etching tungsten using a mixed gas including a fluorine-containing gas that includes a compound having fluorine and carbon in a molecule, the rejections of any of claims 1 to 8 should not be sustained or presented by the Examiner. "To establish prima facie obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. In re Royka,

490 F.2d 981, 180 USPQ 580 (CCPA 1974).["] M.P.E.P. § 2143.03.
Accord. M.P.E.P. § 706.02(j).

For the foregoing reasons, all the claims now pending in the present application are believed to be clearly patentable over the prior art of record. Accordingly, favorable reconsideration of the claims in light of the above remarks is courteously solicited. If the Examiner has any comments or suggestions that could place this application in even better form, the Examiner is requested to telephone the undersigned attorney at the below-listed number.

Respectfully submitted,

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Appendix**Amendments to the Claims**

1. (amended) A dry etching method comprising the step of: dry-etching tungsten with a mixed gas [containing] including a fluorine-containing gas that includes a compound having fluorine and carbon in a molecule, chlorine or hydrogen bromide, oxygen, and nitrogen.
2. (amended) A dry etching method according to claim 1, wherein said fluorine-containing gas has a structure that a ratio of fluorine atoms with respect to elements of the gas molecule except for fluorine is four or less [() when the composition of the fluorine molecule is M_xF_y , $Y/X \leq 4$ where M is an element except for fluorine atom and F is fluorine()].
3. (amended) A dry etching method according to claim 2, wherein said fluorine-containing gas has a structure that the total number of fluorine atoms in elements constituting said gas molecule is four or less [and a carbon atom is contained].
4. (amended) A method of manufacturing a semiconductor apparatus comprising the steps of:
laminating upwards a polycrystal silicon film or an amorphous silicon film, a tungsten nitride film or a titanium nitride film, and a tungsten film on a silicon substrate; and
dry-etching said tungsten nitride film or said titanium nitride film and said tungsten film with mixed gas containing fluorine-containing gas that includes a compound having fluorine and carbon in a molecule, [and] chlorine or hydrogen bromide, oxygen, and nitrogen so that a gate electrode is formed.

6. (amended) A method of manufacturing a semiconductor apparatus according to claim 4, wherein a mask is formed by silicon oxide or silicon nitride, and said gate electrode is formed by [to perform] dry etching using said mask.

7. (amended) A method of manufacturing a semiconductor apparatus according to claim 4, said fluorine-containing gas has a structure that a ratio of fluorine atoms with respect to elements of the gas molecule except for fluorine is four or less [()when the composition of the fluorine molecule is M_xF_y , $Y/X \leq 4$ where M is an element except for fluorine atom and F is fluorine[]].

8. (amended) A method of manufacturing a semiconductor apparatus according to claim 7, wherein said fluorine-containing gas has a structure that the total number of fluorine atoms in elements constituting said gas molecule is four or less [and a carbon atom is contained].